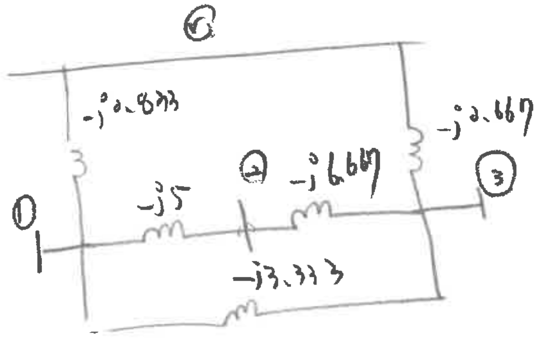
2019 학년도 제 학기 성적평가지

교과목명		시험일자	20 . . .	담당 교수	(서명)	성 적	
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1.



(A) $Y_{bus} = \begin{bmatrix} -j9.166 & j5 & j3.333 \\ j5 & -j11.667 & j6.667 \\ j3.333 & j6.667 & -j10.667 \end{bmatrix}$

(B) 2-3 선로 단선

$Y_{bus} = \begin{bmatrix} -j9.166 & j5 & j3.333 \\ j5 & -j5 & 0 \\ j3.333 & 0 & -j4 \end{bmatrix}$

C)



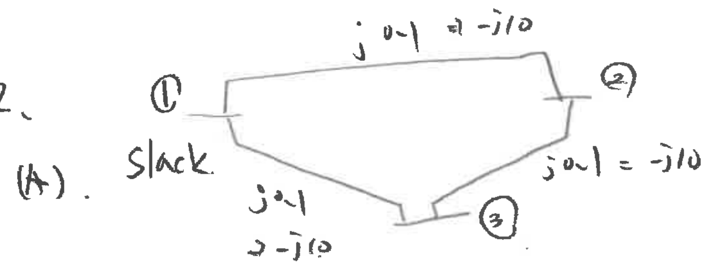
$Y_{bus} = \begin{bmatrix} -j7.023 & j6.19 \\ j6.19 & -j6.857 \end{bmatrix}$

(D) $Z_{bus} = -0.1016 \begin{bmatrix} -j6.857 & -j6.19 \\ -j6.19 & -j7.023 \end{bmatrix}$

$Z_{bus} = \begin{bmatrix} j0.6967 & j0.6289 \\ j0.6289 & j0.7135 \end{bmatrix}$

2.

(A). Slack



$Y = \begin{bmatrix} -j20 & j10 & j10 \\ j10 & -j20 & j10 \\ j10 & j10 & -j20 \end{bmatrix}$

$B = \begin{bmatrix} -20 & 10 \\ 10 & -20 \end{bmatrix}$

(B) $\theta = B^{-1} P$

$B^{-1} = \frac{1}{300} \begin{bmatrix} -20 & -10 \\ -10 & -20 \end{bmatrix}$ $\qquad P_2 = \frac{200}{100} = 2$

$\begin{bmatrix} \theta_2 \\ \theta_3 \end{bmatrix} = \frac{1}{300} \begin{bmatrix} -20 & -10 \\ -10 & -20 \end{bmatrix} \begin{bmatrix} 2 \\ 0 \end{bmatrix}$

$\begin{bmatrix} \theta_2 \\ \theta_3 \end{bmatrix} = \begin{bmatrix} -0.1333 \\ -0.0667 \end{bmatrix}$ (rad)

(C) $P_{12} = \frac{1}{X_{12}} (\theta_1 - \theta_2)$

$= \frac{1}{0.1} (0 + 0.1333) = 1.333\ pu$

$P_{12} = 1.333 \times 100 = 133.3\ MW$

3.

$S_{base} = 30M$ ⇒ 변압기 기준!

(A) $Z_{base} = \frac{(V_{base})^2}{S_{base}} = \frac{(33K)^2}{30M} = 36.3\Omega$

$Z_{Line}^{pu} = \frac{3+j15}{36.3} = 0.08 + 0.413j$

(B)

$X_{G1} = j0.15 \times \frac{30}{20} = j0.225$ pu

$X_{G2} = j0.1 \times \frac{30}{10} = j0.3$ pu

$X_T = j0.05$

$Z_{TH} = (j0.225 // j0.3) + j0.05 + 0.08 + 0.413i$

$= j0.1286 + j0.05 + 0.08 + j0.413$

$= 0.08 +$ ~~0.6086i pu~~

(C) $I_{AC(RMS)} = \frac{1}{0.08 + 0.6086i}$

$= 1.629$ pu

(D) $\tau = 3$ i_{rms}

$i_{rms} = I_{AC}\sqrt{1 + 2e^{-4\pi\tau/(\frac{X}{R})}}$

$= 1.629\sqrt{1 + 2e^{-4\pi \times 3/7.6075}}$

$= 1.64$ pu

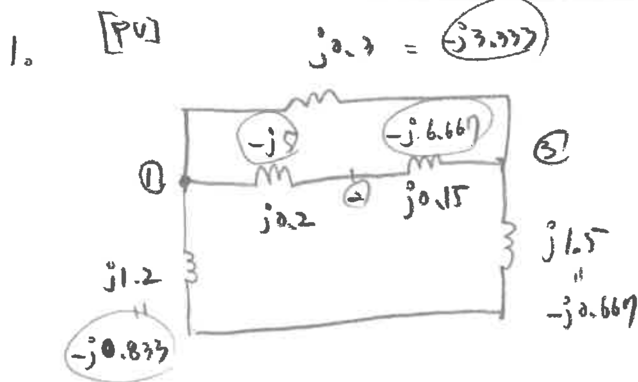
$I_{rms}(t) = I_{ac}\sqrt{1 + 2e^{-2t/T}}$

$= I_{ac}\sqrt{1 + 2e^{-4\pi\tau/(X/R)}}$

20 18 학년도 제 학기 성적평가지

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1. [PU]



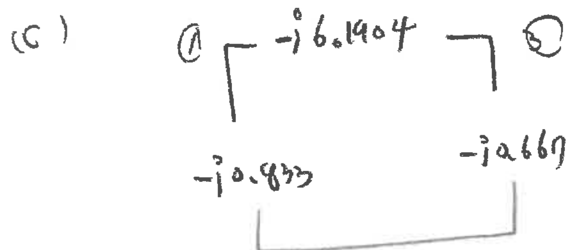
(A).

$$Y_{bus} = \begin{bmatrix} -j6.166 & j5 & j3.333 \\ j5 & -j11.667 & j6.667 \\ j3.333 & j6.667 & -j10.667 \end{bmatrix}$$

(B).

$$Y_{bus} = \begin{bmatrix} -j5.8333 & j5 & j0.833 \\ j5 & -j11.667 & j6.667 \\ j0.833 & j6.667 & -j7.334 \end{bmatrix}$$

(C)



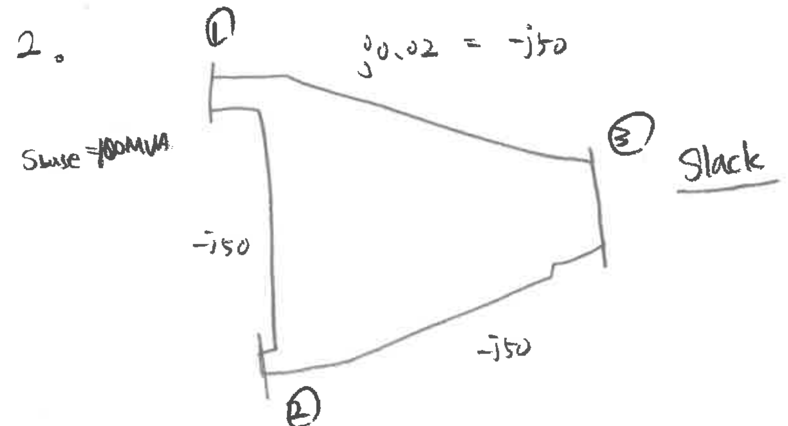
$$Y_{bus} = \begin{bmatrix} -j7.0234 & j6.1904 \\ j6.1904 & -j6.8574 \end{bmatrix}$$

(D). $Z_{bus} = Y_{bus}^{-1}$

$$= -0.1016 \begin{bmatrix} -j6.8574 & -j6.1904 \\ -j6.1904 & -j7.0234 \end{bmatrix}$$

$$= \begin{bmatrix} j0.6967 & j0.6289 \\ j0.6289 & j0.7136 \end{bmatrix}$$

2.



(A) $Y_{bus} = \begin{bmatrix} -j100 & j50 & j50 \\ j50 & -j100 & j50 \\ j50 & j50 & -j100 \end{bmatrix}$

$$B = \begin{bmatrix} -100 & 50 \\ 50 & -100 \end{bmatrix}$$

(B). $\theta = B^{-1} P$

$$B^{-1} = \frac{1}{7500} \begin{bmatrix} -100 & -50 \\ -50 & -100 \end{bmatrix}$$

$$\begin{bmatrix} \theta_1 \\ \theta_2 \end{bmatrix} = \frac{1}{7500} \begin{bmatrix} -100 & -50 \\ -50 & -100 \end{bmatrix} \begin{bmatrix} +0.4 \\ +0.3 \end{bmatrix}$$

$$\begin{bmatrix} \theta_1 \\ \theta_2 \end{bmatrix} = \begin{bmatrix} -0.0073 \\ -0.0067 \end{bmatrix} \quad (rad)$$

(C) $P_{31} = \frac{1}{X_{31}} (\theta_3 - \theta_1)$

$$= \frac{1}{0.02} (0 + 0.0073)$$

$P_{31} = +0.365$ PU

$P_{31} = +0.365 \times 100M = +36.5 MW$

3.

(A) $I_{AC(RMS)} = \frac{V}{Z}$

$I_{AC} = \frac{154k \times 1.05}{|1+j10|\sqrt{3}} = 9289.42 \angle -84.29°$

$I_{AC(rms)} = 9289.42\text{A}$

(B) τ=0.5cycle DC성분

$i_{DC}(t) = -\frac{\sqrt{2}V\sin(\alpha-\theta)}{Z} e^{-t/T}$

$i_{DC}(\tau) = \sqrt{2} I_{ac} e^{-2\pi\tau/(\frac{X}{R})}$

$i_{dc}(0.5) = 9595.46\text{A}$

(C) CB 3cycle I_{rms}

$I_{rms} = I_{ac}\sqrt{1+2e^{-4\pi\tau/\frac{X}{R}}}$

$= 9289.42\sqrt{1+2e^{-4\pi\times3/10}}$

$= 9501.166\text{A}$

$i_{dc}(t) = -\frac{\sqrt{2}V}{Z}\sin(\alpha-\theta_Z)\cdot e^{-t/T}$

$I_{dc} = \sqrt{2}Ie^{-t/T} = \sqrt{2}Ie^{-2\pi\tau/(\frac{X}{R})}$

$I_{ac}\sqrt{1+2e^{-2t/T}} = I_{rms}(t)$

$I_{ac}\sqrt{1+2e^{-4\pi\tau/(\frac{X}{R})}}$

4.

(A) $I'' = \frac{V_{TH}}{Z_{TH}} = \frac{1}{j0.6967}$

$= 1.4353\text{ pu}$

(B) $V_{LL} = 22.9\text{kV}$ $S_{base} = 1000\text{kVA}$

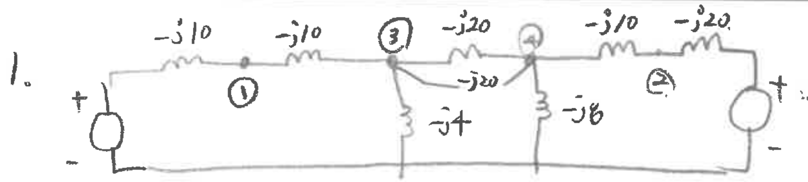
$I_{base} = \frac{1000k}{\sqrt{3}\times22.9k} = 25.21\text{A}$

$I'' = 25.21\times1.4353 = 36.186\text{A}$

20 17 학년도 제 학기 성적평가지

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1.



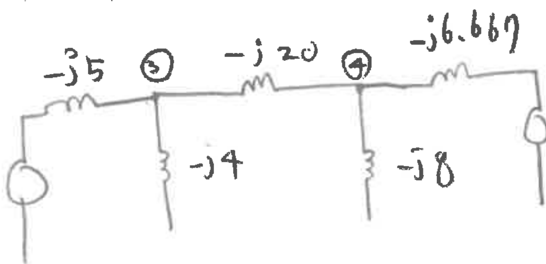
(A) Ybus

$$= \begin{bmatrix} -j20 & 0 & j10 & 0 \\ 0 & -j30 & 0 & j10 \\ j10 & 0 & -j34 & j20 \\ 0 & j10 & j20 & -j38 \end{bmatrix}$$

(B) Ybus

$$= \begin{bmatrix} -j20 & 0 & j10 & 0 \\ 0 & -j30 & 0 & j10 \\ j10 & 0 & -j54 & j40 \\ 0 & j10 & j40 & -j58 \end{bmatrix}$$

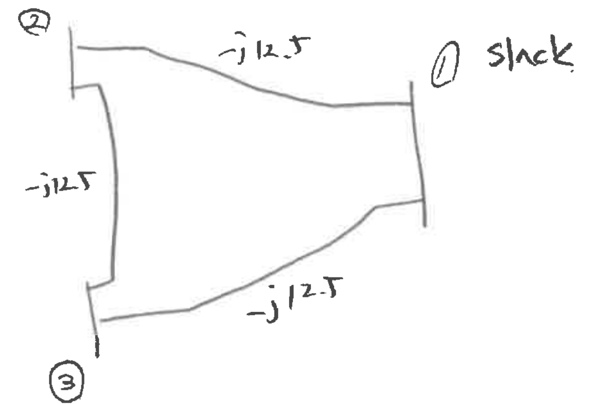
(C) 1, 2 모선 무시.



$$Ybus = \begin{bmatrix} -j29 & j20 \\ j20 & -j34.667 \end{bmatrix}$$

2. Sbase = 100 MVA

$Z_L = j0.08 \Rightarrow Y_L = -j12.5$



(A) $$Y_{bus} = \begin{bmatrix} -j25 & j12.5 & j12.5 \\ j12.5 & -j25 & j12.5 \\ j12.5 & j12.5 & -j25 \end{bmatrix}$$

$$B = \begin{bmatrix} -25 & 12.5 \\ 12.5 & -25 \end{bmatrix}$$

(B) $B\theta = P \qquad \theta = B^{-1} P$

$$\begin{bmatrix} \theta_2 \\ \theta_3 \end{bmatrix} = \frac{4}{1875} \begin{bmatrix} -25 & -12.5 \\ -12.5 & -25 \end{bmatrix} \begin{bmatrix} 2 \\ 1.5 \end{bmatrix}$$

$$\begin{bmatrix} \theta_2 \\ \theta_3 \end{bmatrix} = \begin{bmatrix} -0.14667 \\ -0.1333 \end{bmatrix} \text{(rad.)}$$

(C) $P_{12} = \frac{1}{X_{12}} (\theta_1 - \theta_2) = \frac{1}{0.08} (0.14667)$

$P_{12} = 1.833$ pu

$P_{12} = 1.833 \times 100\ M = 183.3\ MW$

3. 중성점 잔류전압 154kV, 60Hz

(A)

$$E_n = \frac{\sqrt{C_a(C_a-C_b)+C_b(C_b-C_c)+C_c(C_c-C_a)}}{C_a+C_b+C_c} \times \frac{154k}{\sqrt{3}}$$

$$E_n = 0.00529 \times \frac{154k}{\sqrt{3}} = 470.43V$$

$$= 0.47kV$$

(B) $I_c = \omega C E = 2\pi \times 60 \times (0.935+0.95+0.95)\mu \times \frac{154k}{\sqrt{3}}$

$$= 95.026A$$

$$\underset{(합조도)}{P} = \frac{I_L - I_c}{I_c} \times 100 = 10$$

$$I_L = 1.1 I_c = 1.1 \times 95.026$$

$$= 104.529A$$

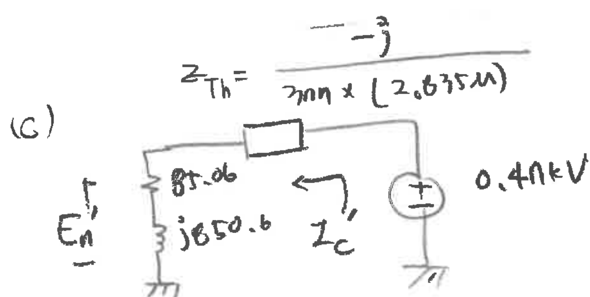
$$I_L = \frac{E}{X} = \frac{154k}{X\sqrt{3}} = 104.529$$

$$X = \frac{154k}{104.529\sqrt{3}} = 850.6\Omega$$

$$X = 850.6\Omega$$

$$Z_{Th} = \frac{-j}{377 \times (2.835\mu)}$$

(C)



$$I_c' = \frac{470}{85.06 + j850.6 + \frac{-j}{377 \times 2.835\mu}}$$

$$= 3.9077 \angle 44.99° A$$

$$E_n' = (85.06 + j850.6) I_c'$$

$$= 3340.505 \angle 129.28$$

$$|E_n'| = 3.34 kV$$

4.

(A). $S_{base} = 100MVA$

$$X_{G_1} = j0.25 \times \frac{100}{50} = j0.5 pu$$

$$X_{G_2} = j0.25 \times \frac{100}{25} = j1 pu$$

$$Z_{base} = \frac{(V_{base})^2}{S_{base}} = \frac{(66k)^2}{200M} = 21.78$$

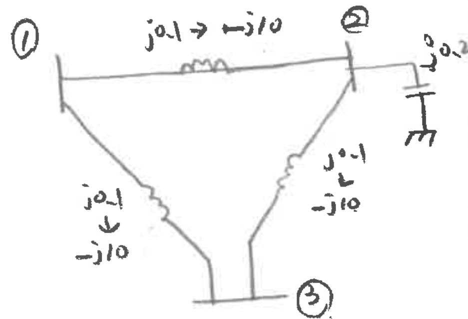
$$Z_T = \frac{j0.2}{21.78} = j0.00918 pu$$

$$Z_T = j0.00918 \times \frac{100}{200} =$$

20 15 학년도 제 학기 성적평가지

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강좌번호		학 과		학 번		성 명	

1.



(A)

$$Y_{bus} = \begin{bmatrix} -j20 & j10 & j10 \\ j10 & -j20 & j10 \\ j10 & j10 & -j20 \end{bmatrix}$$

(B) 커패시터 설치

$$Y_{bus} = \begin{bmatrix} -j20 & j10 & j10 \\ j10 & -j19.8 & j10 \\ j10 & j10 & -j20 \end{bmatrix}$$

(C)

$$P_{32} = \frac{V_3 V_2}{X_{32}} \sin(\theta_3 - \theta_2)$$

$$= \frac{0.99}{0.1} \sin(-2.68 + 7.11)$$

$$= 0.765 \text{ pu}$$

(D) DC power flow

$$B\theta = P$$

$$\begin{bmatrix} -20 & 10 \\ 10 & -20 \end{bmatrix} \begin{bmatrix} \theta_2 \\ \theta_3 \end{bmatrix} = \begin{bmatrix} 2 \\ -0.3 \end{bmatrix}$$

$$\begin{bmatrix} \theta_2 \\ \theta_3 \end{bmatrix} = \frac{1}{300} \begin{bmatrix} -20 & -10 \\ -10 & -20 \end{bmatrix} \begin{bmatrix} 2 \\ -0.3 \end{bmatrix} = \begin{bmatrix} -0.123 \\ -0.0467 \end{bmatrix}$$

$$P_{32} = \frac{1}{0.1}(-0.0467 + 0.123)$$

$$= 0.763 \text{ pu}$$

2. 중성점 잔류 전압 200km, 154kV

(A) $C_a = 0.0045 \times 200 = 0.9 \mu F$

$C_b = 0.0048 \times 200 = 0.96 \mu F$

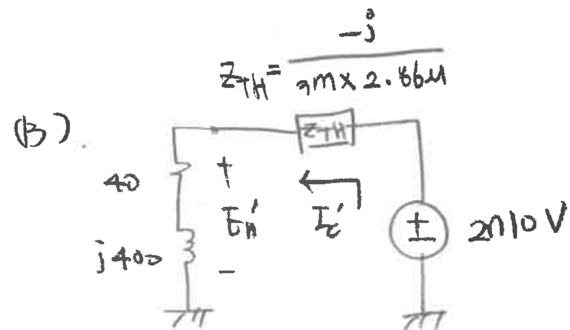
$C_c = 0.005 \times 200 = 1 \mu F$

$$E_n = \frac{\sqrt{C_a(C_a - C_b) + C_b(C_b - C_c) + C_c(C_c - C_a)}}{C_a + C_b + C_c} \times \frac{E}{\sqrt{3}}$$

$E_n = 2710 V$

$$Z_{TH} = \frac{-j}{377 \times 2.86 \mu}$$

(B)



$$I_c' = \frac{2710}{40 + j400 + \frac{-j}{377 \times 2.86 \mu}}$$

$$= 5.123 \angle 85.663 \text{ A}$$

$E_n' = (40 + j400) I_c = 2059.49 \angle 169.95 V$

$|E_n'| = 2059.49 V = 2.059 kV$

√

3. 60Hz, 154kV system

$R = 0.5\Omega$ $X = 10\Omega$

(A) $I_{AC(RMS)} = \frac{V}{Z} = \frac{161.7K}{(0.5 + j10)\sqrt{3}}$ ✱

$V = 154K \times 1.05 \times \frac{1}{\sqrt{3}} = \frac{161.7k}{\sqrt{3}}$

$I_{AC(RMS)} = 9.324 \angle -87.14° \ kA$

$|I_{AC(RMS)}| = 9.324kA$

(B) $\tau = 0.5$ cycle 에서 i_{dc}

$i_{dc} = -\frac{\sqrt{2} V \sin(\alpha - \theta)}{Z} e^{-t/T}$

$= \sqrt{2} I_{ac} e^{-2\pi\tau/(\frac{X}{R})}$

$\frac{t}{T} = \frac{\frac{\tau}{f}}{\frac{X}{\omega R}} = \frac{\tau}{\frac{X}{2\pi R}} = \frac{2\pi\tau}{(\frac{X}{R})}$

$i_{dc} = \sqrt{2} \times 9.324k e^{-2\pi \times 0.5/20}$

$= 11269.34A = 11.269kA$

(C) CB동작 i_{rms} (3cycle)

$i_{rms} = I_{ac}\sqrt{1 + 2e^{-4\pi\tau/(\frac{X}{R})}}$

$= 9.324k\sqrt{1 + 2e^{-4\pi 3/20}}$

$= 10.646kA$

(D) X 유지 $\frac{X}{R} = 5$ $R = \frac{10}{5} = 2$

$I_{ac} = \frac{161.7K}{(2 + 10i)\sqrt{3}} = 9.154kA$

$I_{rms} = 9.154k\sqrt{1 + 2e^{-4\pi \times 3/5}}$

$= 9.159kA$

4.



$S_{base} = 100MVA$, $V_{LL} = 66kV$

(A) 1번 단에서 바라본 Z_{TH}

$(j0.2 + j0.25) // j0.2 = j0.138$ pu

$Z_{TH} = j0.2 // (j0.1 + j0.138)$

$Z_{TH} = j0.109$ pu

(B) $V_{TH} = 1.05\angle 0°$

$I'' = \frac{V_{TH}}{Z_{11}} = \frac{1.05\angle 0°}{j0.109} = 9.633$ pu

$I_{base} = \frac{100M}{\sqrt{3} \times 66k} = 874.77A$

$I''_{act} = 874.77 \times 9.633 = 8.427kA$

☆ (C) $Z_{th}(\Omega) = j4.748\Omega$

$Z_{base} = \frac{(V_{LL})^2}{S_{base}} = \frac{(66k)^2}{100M} = 43.56\Omega$

(D) $E_a = 1.05\angle 0°$

$I_f = I_f^{(1)} + I_f^{(2)}$

$I_f^{(1)} = \frac{1.05 - 1.05}{j0.2} = 0A$

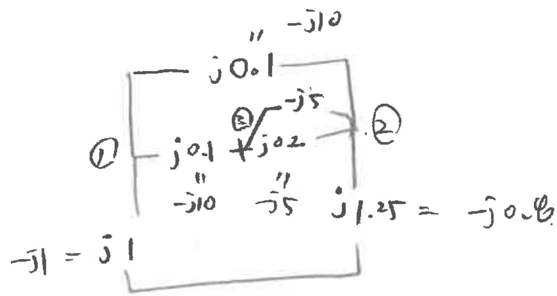
$I_f^{(2)} = \frac{1.05}{j0.2} = -5.25i$

$I_f = -5.25i$ pu

20 14 학년도 제 학기 성적평가지

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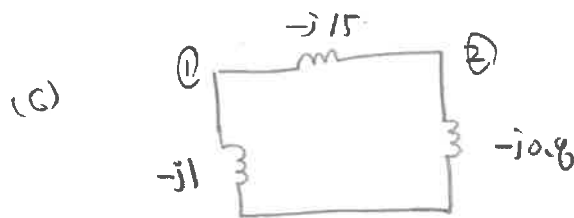
1.



(A) $Y_{bus} = \begin{bmatrix} -j21 & j10 & j10 \\ j10 & -j15.8 & j5 \\ j10 & j5 & -j15 \end{bmatrix}$

(B) $Y_{bus} = \begin{bmatrix} -j21 & j10 & j10 \\ j10 & -j20.8 & j10 \\ j10 & j10 & -j20 \end{bmatrix}$

(C)



$Y_{bus} = \begin{bmatrix} -j16 & j15 \\ j15 & -j15.8 \end{bmatrix}$

(D) $P_{12} = \frac{V_1 V_2}{X_1} \sin(\theta_1 - \theta_2)$

$= \frac{0.99}{X_1} \sin(\delta)$

$= \frac{0.99}{\frac{1}{15}} \sin\delta$

$= 14.85 \sin\delta$

2. 중성점 잔류전압

(A) $C_a = 0.0045 \times 200 = 0.9\mu F$

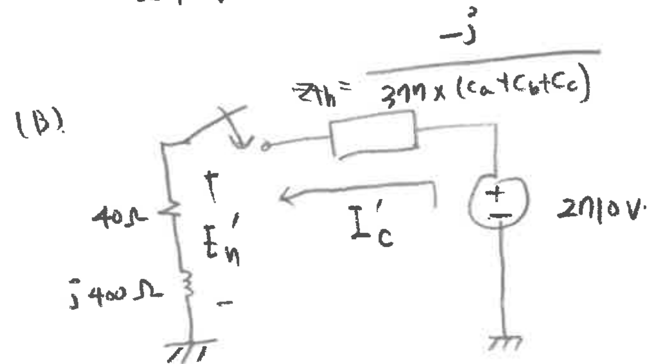
$C_b = 0.0048 \times 200 = 0.96\mu F$

$C_c = 0.005 \times 200 = 1\mu F$

$E_n = \frac{\sqrt{C_a(C_a-C_b) + C_b(C_b-C_c) + C_c(C_c-C_a)}}{C_a+C_b+C_c} \times \frac{154kV}{\sqrt{3}}$

$= 2710\,V$

(B)



$I'_c = \frac{2710}{40 + j400 + \frac{-j}{377 \times 2.86\mu}}$

$= 5.123 \angle 85.663° A$

$E'_n = (40+j400) I'_c = (40+j400)(5.123\angle 85.663)$

$= 2059.49 \angle 169.95° V$

$|E'_n| = 2059.49 V = 2.059 kV$

3. 60Hz 전력시스템.

(A) $V_{TH} = 154k \times 1.05 = 161.7kV$

$$I_{ac\,rms} = \frac{161.7k}{|2+j10|\sqrt{3}} = 9154.46A$$

(B) $\tau = 0.5$cycle DC성분 고장 전류

$$i(t) = i_{ac}(t) + i_{dc}(t)$$

$$= \underbrace{\frac{\sqrt{2}V\sin(\omega t+\alpha-\theta_z)}{Z}}_{(AC)} - \underbrace{\frac{\sqrt{2}V\sin(\alpha-\theta_z)}{Z}\varepsilon^{-t/T}}_{(DC)}$$

$$\therefore i_{dc}(t) = \frac{\sqrt{2}V}{Z}\varepsilon^{-t/T} \quad (\alpha = \theta - \frac{\pi}{2})$$

$$\frac{t}{T} = \frac{\frac{\tau}{f}}{\frac{L}{R}} = \frac{\frac{\tau}{f}}{\frac{X}{2\pi f R}} = \frac{2\pi\tau}{(\frac{X}{R})}$$

$$\therefore i_{dc}(\tau) = \sqrt{2}I_{ac}\varepsilon^{-2\pi\tau/(\frac{X}{R})} \text{ A}$$

$$i_{dc}(0.5) = \sqrt{2}\times 9154.46\times\varepsilon^{-2\pi\times0.5/5}$$

$$= 6906.73A$$

(C) CB가 동작하는 $i_{rms}(\tau)$ $(\tau=3)$

$$i_{rms} = I_{ac}\sqrt{1+2\varepsilon^{-4\pi\tau/(\frac{X}{R})}}$$

$$= 9154.46\sqrt{1+2\varepsilon^{-4\pi\times3/5}}$$

$$= 9159.72A = 9.159kA$$

(D) X유지 $\frac{X}{R}=10$ $R=\frac{10}{X}=1$

$$I_{ac} = \frac{161.7k}{|1+j10|\sqrt{3}} = 9289.42A$$

$$I_{rms}(3) = 9289.42\sqrt{1+2\varepsilon^{-4\pi\times3/10}}$$

$$= 9501.17 = 9.501kA$$

4. $S_{base} = 100M$

(A) $X_{G1} = 0.15\times\frac{100}{20} = j0.75$ pu

$X_{G2} = 0.1\times\frac{100}{10} = j1$ pu

$X_T = 0.05\times\frac{100}{30} = j0.1667$ pu

$$Z_{base} = \frac{V_{base}^2}{S_{base}} = \frac{(33k)^2}{100M} = 10.89\,\Omega$$

$$\therefore X_{Line} = \frac{3+j5}{10.89} = 0.275 + 0.459i$$

(B)



$Z_{TH} = j0.4286 + j0.1667 + 0.275+0.459i$

$= 0.275 + 1.054i$

(C) 모선 1 (고장점)에서 바라본 전체계통의 driving point impedance

$Z_{TH} = j0.75 // j1 // (j0.1667 + 0.275 + j0.459)$

$= j0.429 // 0.275 + j0.6257$

$= 0.0426 + 0.2656i$ pu

$$Z_{base} = \frac{(11k)^2}{100M} = 1.21\,\Omega$$

$\therefore Z_{Th} = 1.21\times(0.0426+0.2656i)$

$= 0.0515 + 0.32i\ \Omega$

(D) 3cycle I'' (고장전류)

$$I_f'' = \frac{V}{Z_{11}} = \frac{1}{0.0426+0.2656i} = 3.72 \text{ pu}$$

$$I_f'' = 3.72\times\frac{100M}{\sqrt{3}\times11k} = 19.524kA$$

20 13 학년도 제 학기 성적평가지

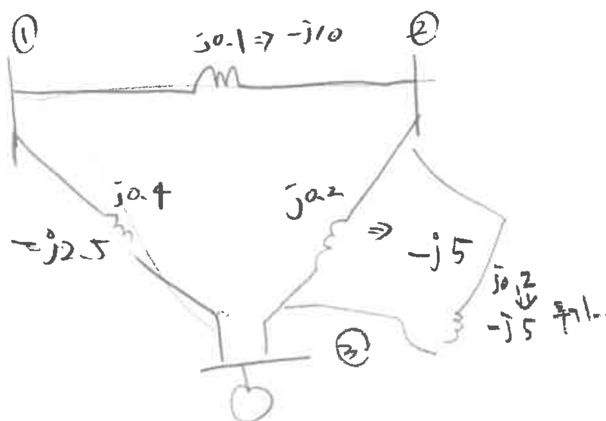
교과목명		시험일자	20 . . .	담 당 교 수	(서명)	성 적	
강좌번호		학 과		학 번		성 명	

1.

(A) $\%Z_g = 10\%$ (20MVA)

$\% Z_{gnew} = 10 \times \frac{100M}{20M} = 50\%$

2.



(A) $Y_{bus} = \begin{bmatrix} -j12.5 & j10 & j2.5 \\ j10 & -j15 & j5 \\ j2.5 & j5 & -j7.5 \end{bmatrix}$

(B) $Y_{bus} = \begin{bmatrix} -j12.5 & j10 & j2.5 \\ j10 & -j20 & j10 \\ j2.5 & j10 & -j12.5 \end{bmatrix}$

(C)

3. $R = 0.03\,PU$, $X = 0.1\,PU$

$V_{base} = 138kV$, $S_{base} = 100MVA$

$I_{base} = \frac{S_{base}}{\sqrt{3}V_{base}}$

(A) $Z_{base} = \frac{(V_{base})^2}{S_{base}} = \frac{(138k)^2}{100M} = 190.44\Omega$

$Z_{TH} = (0.03 + j0.1) \times 190.44 = 5.71 + 19.04j$
$= 19.88\angle 73.3°$

(B) $I_{AC(rms)} = \frac{1}{|0.03 + j0.1|} = 9.578\,PU$

$I^A_{AC(rms)} = 9.578 \times I_{base} = 4007.15A$

$I_{base} = \frac{100M}{\sqrt{3} \times 138k} = 418.77A$

(C) $T = \frac{L}{R} = \frac{X}{wR} = \frac{X}{2\pi fR}$

$= \frac{0.1}{377 \times 0.03} = 8.84\,msec$

(D) $I_{rms} = I_{ac}\sqrt{1 + 2e^{-4\pi \tau / \frac{X}{R}}}$

$= 4007.15\sqrt{1 + 2e^{-4\pi \times 0.5 / \frac{X}{R}}}$

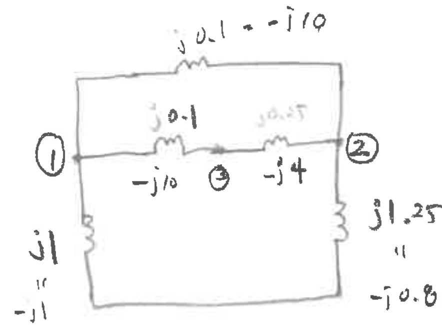
$= 4575.3\,A$

(E) $I_{rms}(3) = 4007.19A$

20 12 학년도 제 학기 성적평가지

교과목명		시험일자	20 . . .	담당 교수	(서명)	성 적	
강좌번호		학 과		학 번		성 명	

1.



(A) $Y_{bus} = \begin{bmatrix} -j21 & j10 & j10 \\ j10 & -j14.8 & j4 \\ j10 & j4 & -j14 \end{bmatrix}$

(B) $P_{13} = ?$ $V_1 = 1\angle 0°$, $V_3 = 1.05\angle -\delta$

$P_{13} = \frac{V_1 V_3}{X_{13}} \sin(\theta_1 - \theta_3) = \frac{1.05}{0.1} \sin(\delta)$ pu

(C) $P_{13} = \frac{1.05}{0.1} \sin(\delta) = 0.6$ pu

$\sin\delta = 0.057$ $\therefore \delta = \sin^{-1} 0.057$

$= 3.28°$

(D) $Z_{23} = 0.25 // 0.25 = 0.125$

$Y_{23} = -j8$

$Y_{bus} = \begin{bmatrix} -j21 & j10 & j10 \\ j10 & -j18.8 & j8 \\ j10 & j8 & -j18 \end{bmatrix}$

3. 고장점 $R = 0.01$ pu $X = 0.1$ pu

고장전 전압 $V_{TH} = 1$ pu

$V_{base} = 138$ kV , $S_{base} = 100$ MVA , $I_{base} = \frac{S_{base}}{\sqrt{3} V_{base}}$

(A) $Z_{base} = \frac{(V_{base})^2}{S_{base}} = \frac{(138k)^2}{100M} = 190.44 \Omega$

$Z_{th} = 190.44 \times (0.01 + 0.1i)$

$= 1.904 + 19.04i = 19.14 \angle 84.29°$

(B) $I_{ac\,rms} = \frac{1}{|0.01 + 0.1j|} = 9.95$ pu

$I_{base} = \frac{100M}{\sqrt{3} \times 138k} = 418.37$ A

$I_{ac(rms)} = 418.37 \times 9.95 = 4.16$ kA

(C) 시정수 $T = \frac{L}{R} = \frac{X}{\omega R} = \frac{X}{2\pi f R}$

$T = \frac{0.1}{2\pi \times 60 \times 0.01} = 0.027$ sec

(D) $\tau = 0.5$ cycle 순시고장전류 (momentary)

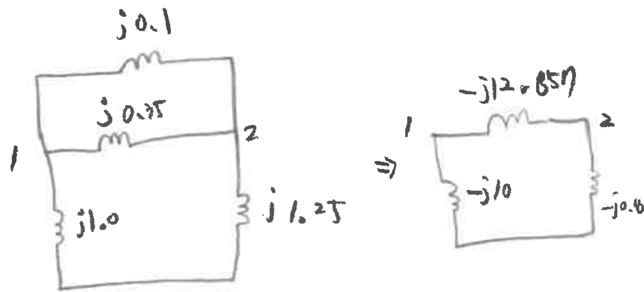
$I_{qrms} = I_{ac} \sqrt{1 + 2e^{-4\pi\tau / \frac{X}{R}}}$

$= 4.16k \sqrt{1 + 2e^{-4\pi \times 0.5 / 10}} = 5.98$ kA

(E) CB 3cycle 동작

$I_{rms} = 4.16k \sqrt{1 + 2e^{-4\pi \times 3 / 10}} = 4.25$ kA

4.



(A) $Y_{bus} = \begin{bmatrix} -j13.857 & j12.857 \\ j12.857 & -j13.657 \end{bmatrix}$

(B) $Z_{bus} = Y_{bus}^{-1} = -0.0418 \begin{bmatrix} -j13.657 & -j12.857 \\ -j12.857 & -j13.857 \end{bmatrix}$

$Z_{bus} = \begin{bmatrix} j0.5709 & j0.5374 \\ j0.5374 & j0.5742 \end{bmatrix}$

(C) 1번 모선에서 바라봤을 때 테브냉 임피던스

$Z_{th} = Z_{11} = j0.5709$ pu

(Z_{bus}에서 Diagonal 성분들은 해당 모선에서 Z_{th})



(D) $I = Y_{bus} V$

$Z_{bus} I = V$

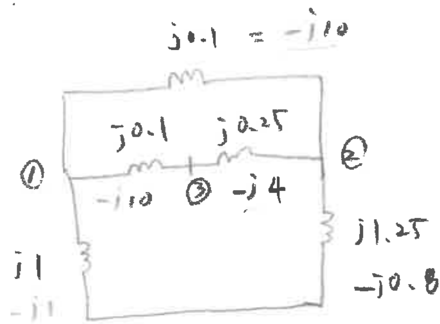
$\begin{bmatrix} j0.5709 & j0.5374 \\ j0.5374 & j0.5742 \end{bmatrix} \begin{bmatrix} I_1 \\ 0 \end{bmatrix} = \begin{bmatrix} V_1 \\ V_2 \end{bmatrix}$

$\Delta V_1 = j0.5709$ pu

20 11 학년도 제 학기 성적평가지

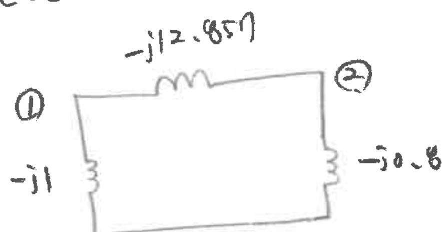
교과목명		시험일자	20 . . .	담당 교수	(서명)	성 적	
강좌번호		학 과		학 번		성 명	

1.



(A) $Y_{bus} = \begin{bmatrix} -j21 & j10 & j10 \\ j10 & -j14.8 & j4 \\ j10 & j4 & -j14 \end{bmatrix}$

(B) 3번모선 X.



$Y_{bus} = \begin{bmatrix} -j13.857 & j12.857 \\ j12.857 & -j13.657 \end{bmatrix}$

(C) $P_{12} = \frac{V_1 V_2}{X_{12}} \sin(\theta_1 - \theta_2)$

$= \frac{1 \times 1.1}{\frac{1}{12.857}} \sin(0+\delta)$

$= 14.15 \sin\delta$

(D) $P_{12} = 14.15 \sin\delta = 0.5$

$\sin\delta = 0.0353$

$\delta = \sin^{-1}(0.0353) = 2.025^\circ$

2. DC power flow

(A) $B = \begin{bmatrix} -21 & 10 & 10 \\ 10 & -14.8 & 4 \\ 10 & 4 & -14 \end{bmatrix}$

(B) $B\theta = P$ $\theta_1 = 0^\circ$ (1번 slack)

$\begin{bmatrix} -14.8 & 4 \\ 4 & -14 \end{bmatrix} \begin{bmatrix} \theta_2 \\ \theta_3 \end{bmatrix} = \begin{bmatrix} 1 \\ 0 \end{bmatrix}$

$\begin{bmatrix} \theta_2 \\ \theta_3 \end{bmatrix} = \frac{5}{956} \begin{bmatrix} -14 & -4 \\ -4 & -14.8 \end{bmatrix} \begin{bmatrix} 1 \\ 0 \end{bmatrix}$

(C) $\begin{bmatrix} \theta_2 \\ \theta_3 \end{bmatrix} = \begin{bmatrix} -0.073 \\ -0.0209 \end{bmatrix}$ rad

(D) $P_{12} = \frac{1}{X_{12}} (\theta_1 - \theta_2)$

$= \frac{1}{0.1} (0 + 0.073)$

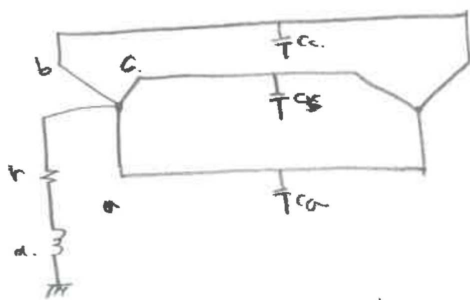
$= 0.73$ pu

∴ $P_{12} = 0.73$ pu (①→②)

$S_{base} = 100$ MVA.

∴ $P_{12} = 0.73 \times 100$ M $= 73$ MW (①→②)

3. 중성점 잔류 전압



200km, 154kV

(A). $C_a = 0.0045 \times 200 = 0.9\ \mu F$

$C_b = 0.0048 \times 200 = 0.96\ \mu F$

$C_c = 0.005 \times 200 = 1\ \mu F$

$$E_n = \frac{\sqrt{C_a(C_a-C_b)+C_b(C_b-C_c)+C_c(C_c-C_a)}}{C_a+C_b+C_c} \times \frac{V}{\sqrt{3}}$$

$$= 0.0305 \times \frac{154k}{\sqrt{3}} = 2710\ V$$

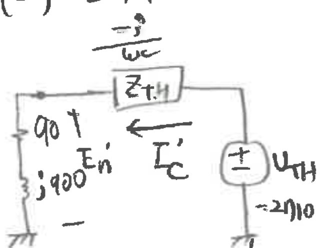
(B) $I_c = wCE = 120\pi \times (0.9+0.96+1)\mu \times \frac{154k}{\sqrt{3}}$

$= 95.86A$

$$I_L = \frac{E}{|r+jx|} = \frac{154k}{\sqrt{90^2+900^2}\ \sqrt{3}} = 98.3$$

합조도 $P = \frac{I_L - I_c}{I_c} \times 100 = \frac{98.3-95.86}{95.86} \times 100 = 2.55\%$

(C) 리액터 접지후 중성점 전압



$$I_c' = \frac{2710}{90+j900 + \frac{-j}{377 \times 2.86u}}$$

$= 28.8 \angle 16.96°\ A$

$E_n' = 28.8 \angle 16.96° \times (90+j900)$

$= 26.05\ kV$

4. $V_{LL} = 20kV$, $R = 2\Omega$, $X = 9.5\Omega$

(A). $I_{acRMS} = \frac{V}{Z} = \frac{20k}{|2+j9.5|}$

$= 2060.1\ A$

(B) $T = \frac{L}{R} = \frac{X}{wR} = \frac{X}{2\pi f R}$

$= \frac{9.5}{120\pi \times 2} = 0.0126\ sec$

(C) $\tau = 0.5cycle$

$i_{rms}(\tau) = I_{ac}\sqrt{1+2e^{-4\pi\tau/(\frac{X}{R})}}$

$= 2.06k\sqrt{1+2e^{-4\pi \times 0.5 \times 0.2105}}$

$= 2.?\ kA$

(D) $\tau = 3cycle$, CB 동작 전류 $= i_{rms}(\tau)$

$i_{rms}(\tau) = 2.06k\sqrt{1+2e^{-4\pi \times 3 \times 0.2105}}$

$= 2.061\ kA$